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A tenth grade biology curriculum guide is presented. The four units of study are Foundations of Life, Variety of Life, Distribution of Life, and Continuity of Life. Also included are an outline course of study, a statement of course objectives, safety rules and regulations, a description of five teaching methods (class discussion, the demonstration, the laboratory, the field trip, and the case study), evaluation methods, audiovisual materials, and a supplement for teaching the slow learner.

The course aims to provide the student with basic concepts pertaining to his environment and to aid him in developing skills in problem solving which are helpful in daily life. Emphasis is placed upon providing opportunities for the student to conduct independent work through active participation in laboratory investigations.

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BIOLOGY 1

OUTLINE COURSE OF STUDY
SENIOR HIGH SCHOOLS
LOS ANGELES CITY SCHOOLS

1963

REPRINTED BY PERMISSION
U. S. DEPARTMENT OF HEALTH, EDUCATION AND WELFARE
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BIOLOGY 1
OUTLINE COURSE OF STUDY

Educational Materials Laboratory
Office of Education
JUN 1965
DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Los Angeles City Schools
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Publication No. SC-597
1963

This publication was developed in accordance with the Comprehensive Curriculum Policy adopted by the Los Angeles City Board of Education.

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FOREWORD

The course of study for Biology 1 has been developed to meet the graduation requirements at the tenth-grade level. Biology 1 is a subject designed to provide the student with basic concepts pertaining to his environment and to aid him in developing skills in problem solving which will be helpful in daily life.

The course emphasizes provision of increased opportunities for the student to conduct independent work through active participation in laboratory investigations. As a result, the student becomes aware of relationships and develops important concepts. In addition, he learns to respect intellectual achievement and the pursuit of excellence by reviewing the work of great scientists. The student also gains an understanding of the attitudes and problems of scientists through the performance of activities which involve problem solving and other scientific methods.

Biology 1 is divided into four areas of study: Foundations of Life; Variety of Life; Distribution of Life; and Change and Continuity of Life. This publication contains an outline course of study, a statement of objectives of the course, safety rules and regulations, a description of five patterns in teaching methods, an evaluation section, references to audio-visual materials, and a supplement for slow learners.

Resource units have been prepared to give teachers specific suggestions for implementing the course. Each resource unit includes concepts to consider, teaching approach (methods and activities), depth probe, "tools" for extending concepts, planning ahead, and broadening "content horizons." The teacher is encouraged to take into consideration individual differences through the proper selection of learning experiences by use of depth probes. These are cited whenever possible to help point out suitable levels of learning activities for the slow learner, for the average student, and for the more able student.

It is hoped that this publication will serve as an aid in the improvement of instruction not only through its use by individual teachers, but also through discussion of the contents by faculty members and in-service training groups.

EVERETT CHAFFEE
Associate Superintendent
Division of Instructional Services

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The Curriculum Branch wishes to express appreciation to the members of the Biology Curriculum Committee who acted in an advisory capacity during development of the organization, content, and sequence of the Outline Course of Study for Biology 1.

Special appreciation is expressed to RUTH KOPF who developed and organized the material in the Outline Course of Study for Biology while working as a science curriculum consultant.

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A PHILOSOPHY OF SCIENCE EDUCATION

Since the launching of the first space satellite, science teachers have recognized that the individual citizen must have a greater knowledge of a variety of sciences. How this can be accomplished has been the subject of much discussion and controversy in science education. Because of significant advances in the field of biology, basic thinking on the teaching of this course has undergone a great transformation. It has been pointed out that:

> A general reorientation in educational aims and means is required as a consequence of developments in modern biology. This reorientation entails helping both the teacher and the high school student to develop the competencies and habits required to read and learn for himself. If students are to continue to be conversant with developing biological science after they have completed their formal schooling, they will need to learn without benefit of schooling and teachers. Obviously, this is also a prime requirement for teachers. It is not only a necessity, but is desirable as the solution to the problem of coverage in teacher preparation. Thus there are two general goals to guide us: (1) an understanding of the changing nature of biological science, and (2) the development, in both teachers and high school students, of the competencies necessary for independent study.[1]

The same author also emphasized that "Biology is changing from an empirical science to a science in which the invention of concepts and conceptual structures is taking a progressively more important role."[2] In view of this trend, the philosophy of science education has become increasingly important. It is clear that:

> When one looks at learning and teaching, the two sides of the same coin, one recognizes, that the intent of the good teacher is to help the student develop concepts. We shall propose that the most useful way of doing this is through the process of forming concepts. Similarly, we shall propose that the meat of science, its content, is the concepts and the conceptual schemes of science.

---

[1]Evelyn Klinckman, BSCS Biology Guidelines for Preparation of In-Service Teachers (Biological Science Curriculum Study Special Publication No. 1, American Institute of Biological Sciences), pp. 3-4.

[2]Ibid., p. 3.

> Then the concept formation is the intent of science and the concepts formed are its content. When this intent and this content are fused in teaching effective education in science is approached.
>
> A concept includes similar elements, related facts. It may help us to discriminate, classify, and analyze. It may also help us to combine, associate, and synthesize. A conceptual scheme is a relationship between a number of concepts. The knowledge gained in understanding such schemes, arbitrary as the area encompassed by any such scheme may be, is transferable; it may be applied to many situations.[3]

Teaching biology to tenth graders becomes a personal invention in which each teacher uses those techniques which are most effective for him. At the same time there are increased efforts to provide individual instruction to large classes. Science teachers are also confronted with the how's and what's of biology. This is only one of the ways in which the Los Angeles City Schools are seeking to make a three-dimensional experience for tenth-grade students. It is also an attempt to establish materials and methods that will reflect biological concepts and the emphases of science as a whole.

---

[3]Paul F. Brandwein, Fletcher G. Watson, and Paul E. Blackwood, Teaching High School Science: A Book of Methods (New York: Harcourt, Brace, 1958), pp. 109-111.

"POINT OF VIEW" AS INTERPOLATED THROUGH BIOLOGY

The Biology 1 course is particularly well suited to the achievement of educational objectives as stated in Point of View.*

INTELLECTUAL DEVELOPMENT: "GROWING IN KNOWLEDGE AND SKILLS AND IN ABILITY TO THINK EFFECTIVELY IN ORDER TO MAKE WISE DECISIONS AND TO TAKE INTELLIGENT ACTION."

The study of Biology 1 as part of general education stresses understanding the student's environment and its effects on his daily living. Biology instruction emphasizes the need to learn for learning's sake; to encourage and stimulate intellectual curiosity; to create opportunities for improving skills in observation, for collection and interpretation of data, and for evaluation of these facts through critical thinking. The student becomes aware of relationships and develops important concepts through laboratory investigations. In addition, he learns to respect intellectual achievement and pursuit of excellence by reviewing the work of great scientists. The student also develops the abilities to evaluate critically and to make wise decisions, which are basic to an educated citizenry.

CIVIC RESPONSIBILITY: "BECOMING A LOYAL, INFORMED, PARTICIPATING CITIZEN--ONE WHO KNOWS THE AMERICAN HERITAGE, WHO APPRECIATES THE PRINCIPLES OF AMERICAN DEMOCRACY, AND WHO UNDERSTANDS LOCAL, NATIONAL, AND WORLD CONDITIONS."

Biology 1 helps students to understand the implications and the applications of scientific research in modern life, and the importance of conservation practices within the student's own community and throughout the world. The student becomes aware of local, national, and international legislation for sustaining the "balance in nature." He learns through laboratory investigations that wholesome scientific research takes place through the combined efforts of his classmates. The student becomes aware that scientists working together depend on each other and the public for their continued support and success. He also has many opportunities to increase his scientific "literacy" so that he will be able to appreciate contributions made by people of other cultures and to recognize the significance of scientific advances.

*Point of View (1961 Revision. Los Angeles City Schools: Publication No. 470). pp. 4-19.

ECONOMIC COMPETENCY: "THAT EACH PERSON WILL BECOME SUCCESSFUL IN A VOCATION AND WELL INFORMED AS A CONSUMER, AND WILL ATTAIN BASIC ECONOMIC UNDERSTANDINGS."

Biology instruction encourages growth in skills and methods of science. The student learns that science and technology have provided better materials for home construction, new and more effective means of communication and transportation, new types of foods, devices that yield power, and increased mechanical efficiency which has led to the development of mass production. The student becomes aware of the interrelatedness of supply and demand. In addition, biology instruction indirectly provides a wide variety of information about careers in scientific and related fields so that the student may discover through his own abilities, aptitudes, and interests a proper and useful vocation.

CREATIVITY: "THAT EACH PERSON WILL THINK AND ACT CREATIVELY IN SOME PHASE OF THE ARTS, SCIENCES, OR HUMANITIES AS PART OF HIS PERSONAL LIFE, HIS VOCATION, AND HIS CIVIC PARTICIPATION.

Biology 1 provides opportunities for students to do independent work through active participation in laboratory activities. Recognition that scientific research is creative will encourage students to become involved in projects of high interest that may eventually lead to vocational choices. Students gain an understanding of the attitudes and problems of scientists through the use of problem-solving techniques in the laboratory.

VALUES: "THAT EACH PERSON WILL DEVELOP AND CHERISH HIGH MORAL, SPIRITUAL, AND ESTHETIC VALUES."

Biology instruction helps the student to understand that his ability to participate in scientific investigations can be challenging and rewarding in thought and invention. He will recognize the orderliness in nature and gain new insight into the beauties of living things through field trips, laboratory experiences, and other activities. Students learn that scientists, like other people, are capable of error, but that values such as faith, courage, honesty, goodwill, and responsibility help them to correct and revise data by means of further scientific research.

HUMAN RELATIONS: "THAT EACH PERSON MAY LEARN TO LIVE AND WORK HARMONIOUSLY WITH EACH OTHER."

Instruction in Biology increases the student's awareness that teamwork during laboratory investigations is based on mutual respect. Students learn that science is international...and that some of the greatest discoveries have come from scientists of various other nations, religions, and races.

HEALTH: "THAT EACH PERSON WILL DEVELOP AND MAINTAIN PHYSICAL AND MENTAL HEALTH."

Biology instruction develops a knowledge of safety precautions which are important in the science laboratory. The student becomes aware of the necessity for similar safety precautions in daily life and develops understandings that will contribute positively to his physical and mental health. He is exposed to a wide spectrum of interests from which he may develop a lifelong hobby or recreational pursuit.

OBJECTIVES OF BIOLOGY 1

To Develop an Understanding and Appreciation of:

The interdependence of living things

The role of biology and its impact and influence on our society, our country, and our world

To Develop an Understanding of:

Energy relationships and interrelationships; on the molecular level, as in chemical bonding; on the micro level, as in biosynthesis and photosynthesis; and on the macro level, as in temperature, light, color, and others

An up-to-date concept of the basic life processes related to cellular structure and the cellular nature of living things

Molecular nature of living things

Methods by which scientific knowledge has been evolved slowly and painstakingly through planned observations and experiments

Need of scientific literacy as essential to learning and communication of ideas

To Develop an Appreciation of:

The history of science and great scientists in an attempt to inspire and develop character

The wise and effective use of natural resources and of the products of science and technology

The many opportunities that science offers to create interests for leisure activities and vocational choices

The orderliness in nature

How to participate in scientific activity which can be challenging and rewarding in thought and invention

To Develop Skills In:

Reading for exact meaning and in interpreting data to gain a better understanding of scientific information

Critical thinking for solving problems of everyday life

Techniques of using materials and equipment for scientific investigations by means of laboratory activities

Ability to read and comprehend the literature of science and to write with clarity about this field

Ability to obtain and organize information

Methods of observation and in accurate recording of results of experiments

To Develop and Stimulate:

An increasing awareness that scientists, like other men, are capable of error and a realization that much can be done through scientific research to correct, revise, and replace out-dated knowledge

An attitude of critical analysis and intelligent evaluation of the recent advances in biology

SCIENCE PROGRAM FOR SECONDARY SCHOOLS

Junior High School Science Requirements

B8 - Science 1
A8 - Science 2
B9 or A9 - Science 3
A9 - Science 4 - Elective
Science majors are directed into appropriate mathematics sequence in the B9 and A9, enrolling in Algebra 1 and 2.

Senior High School Science Requirements

College Preparatory Science Majors		College Preparatory Other Than Science	Terminal
Science	Liberal Arts Science		
10th Grade Biology 1 Biology 2	Biology 1 Biology 2	Biology 1	Biology 1
11th Grade Chemistry 1 Chemistry 2	Chemistry 1 Chemistry 2	One year of laboratory science in 11th or 12th grade. A choice of: Chemistry 1 Chemistry 2 Physiology 1 Physiology 2 Advanced Biology 1 Advanced Biology 2 Physics 1 Physics 2 Advanced Physical Science 1 Advanced Physical Science 2	One year of laboratory science in 11th or 12th grade. A choice of: Modern Science 1 Modern Science 2 Industrial Science 1 Industrial Science 2
12th Grade Physics 1 Physics 2	One year of laboratory science in 12th grade. A choice of: Physiology 1 Physiology 2 Advanced Biology 1 Advanced Biology 2 Physics 1 Physics 2		
MATHEMATIC REQUIREMENT: Algebra 1* Algebra 2* Geometry 1 Geometry 2 Algebra 3 Algebra 4 Trigonometry Math Analysis	MATHEMATIC REQUIREMENT: Algebra 1 Algebra 2 Geometry 1 Geometry 2 Algebra 3 Algebra 4		

*Taken in 9th grade.

SCIENCE BACKGROUND OF TENTH-GRADE STUDENTS

ELEMENTARY SCHOOL*

In each of the following categories are listed pupil understandings developed from Kindergarten through Grade Six. Not every category is applicable to every grade.

PART I

Plant Life

General Information
Needs for Growth
Man's Use of Plants
Interdependence of Plants and Animals
Growth and Reproduction

PART II

Animal Life

General Information
Growth and Reproduction
Man's Use of Animals

PART III

Earth

General Information
Rocks and Soil
Air
Water
Weather

PART IV

Space Beyond the Earth

General Information
Sun
Moon
Solar System

PART V

Machines

General Information
Friction
Simple Machines

PART VI

Energy

General Information
Light
Heat
Sound
Magnetic
Electrical
Solar
Nuclear

*Science in the Elementary School: Basic Institute Material for Grades Kindergarten Through Six. (Los Angeles City Schools: Division of Instructional Services, Instructional Bulletin No. EC-27, 1961-62), p. viii.

JUNIOR HIGH SCHOOL

Science 1 B8

UNIT I

WAYS OF THE SCIENTIST
What Is Science?
Fields of Science
Accuracy of Our Judgments
Methods of the Scientist
Tools of the Scientist

UNIT II

BUILDING BLOCKS OF UNIVERSE
What Is Matter?
General Properties of Matter
States of Matter
How Materials Are Put Together
How Matter Can Be Changed
Chemical Composition of Matter

UNIT III

AN INTRODUCTION TO LIVING THINGS
Activities of Living Things
Conditions of Life
Building Blocks of Life
Human Body

Science 2 A8

UNIT I

MAN AND SPACE
What Our Universe Is Like
What Our Solar System Is Like
Satellites
Artificial Satellites

UNIT II

THE CHANGING EARTH
Theories as to Origin of Earth
Nature of Earth's Interior
Our Changing Earth

UNIT III

INTERRELATIONSHIPS OF LIVING THINGS
Study of a Typical Seed Plant
Study of a Typical Animal Group--The Insects
Study of a Community of Living Things--The Seashore

Science 3 B9 or A9

UNIT I

ENERGY
The Nature of Energy
Structural Relationships of Matter and Energy
Energy and Wave Length

UNIT II

METEOROLOGY
Heat Energy and Weather
The Nature of the Atmosphere
Weather Measurements and Their Use
Greater Weather Patterns

UNIT III

FRONTIERS OF SCIENCE
Oceanography
Exploration of Space
New Developments in Biology

TEACHING OF BIOLOGY 1

Science is so much a part of the lives of everyone that it is of necessity becoming increasingly important in our modern high school curriculum. The college-preparatory student may, indeed, become a scientist. The terminal student may become one of the many citizens better educated and prepared to take his place in a world that science has transformed. A course required in the tenth grade, Biology 1 is designed to develop in students an understanding of basic biological principles.

The course emphasizes the modern concepts of photosynthesis, genetic structure, and cellular metabolism. It is intended to encourage a wider knowledge and understanding of how chemistry and physics are interrelated to the living organism and enables class members to study life from the "atom up." It is intended to spur the student's curiosity to investigate his environment both microscopically and macroscopically and create a climate for understanding concepts about the interrelationships of plants and animals, species, communities, populations, and man's place in nature (past, present, and future). In addition, the implications of scientific discoveries and of the impact that many great scientists have had on our lives are emphasized.

The methods of instruction in Biology 1 are based upon the development of skills in critical thinking. Therefore, the teacher has the responsibility of providing opportunities for students to develop understanding and thoughful behavior and action. Regular classwork in Biology 1 will include active student participation in laboratory experiments. Observation, experimentation, gathering and organizing facts, and drawing conclusions are experiences which result in developing the skills of critical things. Thus, they should be the principal methods utilized by students.

Biology 1 should help students to become more aware of the implications and applications of science and technology so that they may learn to live more effectively; to develop increased scientific literacy; and to learn to be more intelligent in dealing with the complicated problems that they will face as citizens in a democratic society.

OUTLINE COURSE OF STUDY

UNIT ONE: FOUNDATIONS OF LIFE

I. Overview

II. Chemical Background

III. Origin of Life

IV. Modern Concept of the Cell

UNIT TWO: VARIETY OF LIFE

I. Basis for Organization

II. Organization of Living Things

III. Variety in Animals

IV. Variety in Plants

UNIT THREE: DISTRIBUTION OF LIFE

I. Web of Life

II. Populations and Communities

III. Ecological Biogeography

UNIT FOUR: CHANGE AND CONTINUITY OF LIFE

I. Continuity of Life

II. Patterns in Heredity

III. Changes in Living Things

UNIT ONE: FOUNDATIONS OF LIFE

The outline of content and concepts for Unit One are intended to develop understandings of the physical and chemical nature of living systems. Whether these systems be plant or animal, they are shown to be fundamentally similar in function despite the vast differences in structures.

This unit provides for a further development of concepts established in the junior high school science program. The world of molecules and atoms that ultimately make up cytoplasm should be emphasized as much as the structure and function of cells. Basic understandings of the origin of life are brought into focus. Photosynthesis, synthesis of new molecules from nutrients in cell cytoplasm, and the production of chemical energy from these molecules by mitochondria are some of the more recent areas of science which are included in this unit.

Estimated teaching time: 6 weeks

UNIT ONE: FOUNDATIONS OF LIFE

CONCEPTS TO BE DEVELOPED

Matter is anything that occupies space and has mass and inertia.

All matter possesses energy in one form or another.

Matter and energy can neither be created nor destroyed, but can be transformed from one into the other.

There are three principal particles which make up atoms: positive protons, neutral neutrons, and negative electrons.

Isotopes are atoms of the same element having a different number of neutrons and a difference in atomic weight.

An element is a substance in which the atoms are all alike.

Molecules are the smallest particles of a substance that can exist in the free state and which have all the properties of the substance.

Molecules of all substances are in constant motion.

The valence of an element is a number which indicates the combining power of an atom in its union with other atoms.

Chemical bonding is the exchange or sharing of one or more electrons between atoms which unite in chemical reactions.

Formulas consist of symbols showing the number and kinds of atoms present.

The cell is the unit of structure and function in living organisms.

All cells come from previously existing cells.

Viruses are particles smaller than most cells which are composed of protein and nucleic acid. They are unable to grow and carry out any of the processes characteristic of living things outside a living cell.

Bacteria are basically acellular organisms but in some cases may be aggregated together into colonies and other multicellular masses. They lack a definable nucleus; are generally heterotrophic; and are ubiquitous.

The most important bacteria are those found in the soil and ocean, which cause decay and play an important part in the releasing of nitrogen gas and of fixing nitrogen; and those bacteria which cause disease.

Slime molds show both plant-like and animal-like phases in their life cycle.

Blue-green algae are basically acellular organisms but in some cases the cells may be aggregated together into colonies and other multicellular masses. They lack a definable nucleus and have diffused photosynthetic pigments.

Unicellular organisms, which are very often classified according to their motility, are animal-like protists call Protozoa.

Some forms of Protozoans live as disease-causing parasites in the bodies of men and animals.

Protoplasm is the physical basis of life.

Living cells require food and oxygen for energy and growth and must eliminate carbon dioxide, water, and urea.

The four basic constituents in the cell's raw materials are carbon, hydrogen, nitrogen, and oxygen.

An enzyme is a protein that changes the rate of a chemical reaction.

All cells tend to build larger molecules from relatively few intermediate building units.

The energy releasing process in cells is cellular respiration. In this form of oxidation most of the energy given off is heat while light is rarely released.

Enzymes are specific in the reactions that they catalyze. In many cases, there is a high degree of specificity.

The energy that supplies all life on the earth comes ultimately from sunlight through the process of photosynthesis.

UNIT ONE: FOUNDATIONS OF LIFE

OUTLINE OF UNIT CONTENT*

I. Overview

- A. Living vs. Nonliving
- B. Review of Matter and Energy

II. Chemical Background

- A. Submicroscopic Behavior of Particles in Atoms
- B. Structure of Molecules
- C. Chemical Bonding
- D. Structural Formulas

III. Origin of Life

- A. Theories
  - 1. Cosmozoic ("dust particles" carrying spores)
  - 2. Heterotroph Hypothesis (protein aggregates)
  - 3. Spontaneous Generation
    - a. Redi
    - b. Spallanzani
    - c. Pasteur
  - 4. Cell Doctrine -318 - 3[illegible].
    - a. Schleiden
    - b. Schwann
    - c. Virchow

*Learning experiences and student activities correlated with this outline course of study have been developed in resource units and may be secured from the Curriculum Branch, Division of Instructional Services.

5. Microscope

a. Historical Background

b. Laboratory Technique (Use of the microscope)

B. Units of Life (Protists)

1. Virus

a. Basic Characteristics

b. Recent Information

c. Distribution

2. Rickettsial Organisms

a. Basic Characteristics

b. Recent Information

c. Distribution

3. Bacteria

a. Basis for Identification

(1) Shape

(2) Others

b. Basic Characteristics

c. Recent Information

d. Distribution

e. Feeding

(1) Autotrophs

(2) Heterotrophs

f. Oxygen Consumption

(1) Aerobic

(2) Anerobic

g. Bacteria and the Nitrogen Cycle

h. Bacteria and Diseases

4. Blue-Green Algae

a. Basic Characteristics

b. Distribution

5. Slime Molds

a. Basic Characteristics

b. Distribution

6. Protozoa (Animal-like Protists)

a. Amazing Varieties and Complexities

b. Basis for Identification (Basic Characteristics)

(1) Ameba and Kin

(2) Ciliates

(3) Sporozoans

(4) Suctorians

c. Distribution

d. Protists and Diseases

IV. Modern Concept of the Cell

A. Shapes and Sizes

B. Structure and Function of Cell Parts

1. Cytoplasm

2. Cell Boundaries

a. Cell Wall

b. Plasma Membrane

(1) Diffusion

(2) Osmosis

(3) Active Transport

(4) Others

3. Endoplasmic Reticulum

4. Nucleus (Control Center) D N A and R N A

5. Nucleolus

6. Mitochondria

7. Ribosomes (Microsomes)

8. Plastids

9. Golgi Complex (Lipochondria)

10. Centrosome

C. Cellular Physiology

1. Necessary Nutrients
    a. Proteins and Enzymes
    b. Carbohydrates
    c. Lipids
    d. Minerals
    e. Vitamin and Growth Factors
2. Gas Exchanges
3. Respiration (Production of Internal Energy...ATP-ADP Cycle)
4. Utilization of Energy
    a. Muscle Contraction
    b. Nerve Transmission
    c. Synthesis of Macromolecules
    d. Bioluminescence
    e. Others
5. Photosynthesis and Other Forms of Biosynthesis
    a. Photolysis
    b. CO_2 Fixation
    c. Phosphorylation
    d. Protein Synthesis (D N A - R N A)
    e. Other Forms of Biosynthesis
        (1) Purple Bacteria
        (2) Sulfur Bacteria
        (3) Others

UNIT TWO: VARIETY OF LIFE

The outline of content and concepts for Unit Two are designed to help students develop an understanding of the degrees of differences and similarities among living organisms. The background gained in Unit One regarding the cellular level of living things has provided an important basis for development of this understanding.

Students will become more aware of the great diversity among living things. Instruction in Unit Two stresses the system of organization, its early beginnings, and later developments. The diversity of structure, form, function, and development and evolutionary implications are emphasized. Plant and animal organization has been revised to be consistent with modern concepts and with a "natural classification" to reflect the evolutionary history of a group. Students will develop background necessary for the study of the diversity of habitats which will be covered in the next unit.

Estimated teaching time: 3-4 weeks

UNIT TWO: VARIETY OF LIFE

CONCEPTS TO BE DEVELOPED

Homologous structures are structures that are similar and which are located in corresponding parts of the bodies of organisms.

Organisms having the same anatomical pattern do belong to the same biologically evolving population.

Members of a species can interbreed and produce fertile offspring.

A species is a group of individuals of historically recent common descent, suited to the same environment and manner of living and capable of reproducing among themselves.

All living things plant and animal alike, are related by development from common origins, from which they evolved along separate paths to their present state of divergence.

The basic taxonomic unit is the species.

Classification is an arbitrary method of placing living organisms into orderly groups which are based on structural characteristics.

The more complex that an animal is in structure, the greater is the division of labor among these various structures.

Plants and animals show a gradual increase in complexity in organization.

UNIT TWO: VARIETY OF LIFE

OUTLINE OF UNIT CONTENT*

I. Basis for Organization

- A. Resemblance (Homology)
- B. Homoplasy (Analogy)

II. Organization of Living Things

- A. Nomenclature and Taxonomy (Linnaeus and Others)
- B. The System (A Sample Classification)
- C. Overview of Plant and Animal Classification

III. Variety in Animals

- A. Basic Animal Characteristics
- B. Multicellularity
  - 1. Lower Forms of Animal Life
    - a. Porifera
    - b. Coelenterates
    - c. Worms
  - 2. More Complex Forms of Animal Life
    - a. Mollusks
    - b. Echinoderms
    - c. Arthropods
    - d. Vertebrates

*Learning experiences and student activities correlated with this outline course of study have been developed in resource units and may be secured from the Curriculum Branch, Division of Instructional Services.

C. Evolutionary Patterns and Comparative Significance

IV. Variety in Plants

A. Basic Plant Characteristics

B. Lower Forms of Plant Life

C. More Complex Plants

1. Mosses and Liverworts

2. Vascular Systems
(Conditions for Land Life)

3. Vascular Plants

a. Ferns

b. Horsetails

c. Club Mosses

d. Seed Plants

(1) Cone

(2) Flower

D. Evolutionary Patterns and Comparative Significance

UNIT THREE: DISTRIBUTION OF LIFE

The outline of content and concepts for Unit Three will develop student understanding of conditions which affect the growth and distribution of living things. Units One and Two have provided the background for this study.

Students will learn that the biosphere, the zone of life over the surface of the earth, is a dynamic system of interlocked living and inorganic processes. This unit also stresses basic understanding of factors in our physical environment, such as temperature, moisture, light, and food, which determine to a great extent why certain forms of life exist in one part of the world rather than in some other part. Also emphasized is the fact that most forms of life are capable of adapting themselves to the conditions of their habitat because of certain modifications in their biological structure. Students develop a perspective of the distribution of life and man's place through the study of concepts concerning the importance of food chains and food webs, chemical cycles in the transfer of energy, and populations and their interactions, from the ecological niche through the biogeographic realms.

Estimated teaching time: 3-4 weeks

UNIT THREE: DISTRIBUTION OF LIFE

CONCEPTS TO BE DEVELOPED

The capture of basic energy is through photosynthesis by producer organisms (green plants or green protists).

The greatest mass and energy occur in producers (photosynthetic organisms) and, as each step of the food pyramid progresses, there is a proportional loss in mass and energy for each succeeding consumer organism.

The sequence of species through which materials and energy pass is a food chain.

The many branchings and cross connections among food chains in a biological community is a food web.

The flow of chemicals circulates in characteristic paths from the environment to organisms to environment to organisms over and over again.

Plant and animal communities are interdependent.

When man interferes with the dynamic equilibrium in a natural community, the results may be far reaching and difficult to correct.

Population is a group of organisms of the same or similar species which occupy a given area.

Characteristics of a population are the function of the whole group and not of a single individual. These include population density, birth rate, death rate, rate of migration, rate of emigration, and age distribution.

Once a population becomes established in a certain region and has reached the equilibrium level, the numbers of the population will vary from year to year. Some of these variations will be regular and cyclic.

Populations have a tendency to disperse in all directions until some barrier is reached.

Any given area tends to have an orderly sequence of communities, which changes along with the physical conditions. This development finally leads to a stable, mature community, or climax community.

The amount of solar radiation received is the key environmental factor for living organisms.

The maximum and minimum tolerances of an organism limit the kinds of environments in which it can survive.

Major climatic regions result from the uneven distribution of radiant energy from the sun and the consequent movements of masses of air.

Each species in an established community has a distinctly different place.

The habitat of an organism is the place where it lives, a physical area. Habitat is some specific part of the earth's surface, air, soil, or water.

Plant and animal populations are controlled by environmental limitations.

Soil, temperature, and rainfall have a vital role and vary with geographic latitude and altitude. These factors tend to divide the soil-surfaced earth into a number of distinct habitat zones: desert, grassland, rain forest, deciduous forest, taiga, and tundra.

Temperature decreases with elevation. Decreases of 3°F every 1000 feet of altitude are equivalent to the same decreases in temperature experienced each time one advances northward 3 degrees of latitude.

Living conditions grow more severe as both latitude and altitude increase. Only those life forms especially adapted to low temperature, rocky terrain, and scarcity of vegetation are able to survive on the upper slopes of mountains.

Factors which most affect living things in fresh-water lakes and ponds are temperature, oxygen, sunlight, movement of water, and impurities.

Like the land, the ocean consists of regions characterized by different physical conditions. Consequently, these regions are inhabited by specific kinds of plants and animals. This zonation shows a vertical rather than a horizontal stratification.

UNIT THREE: DISTRIBUTION OF LIFE

OUTLINE OF UNIT CONTENT*

I. Web of Life

A. Interdependence of Plants and Animals (Producer, Consumer, and Decomposer)

B. Food Chains and Pyramids

C. Cycles (Mineral and Others)

1. Carbon
2. Nitrogen
3. Calcium
4. Water
5. Carbon Dioxide
6. Others

D. Man in Nature

1. Forest Fires and Control
2. Flood Control
3. Water Conservation
4. Animal Conservation (Predator - Prey)
5. Others (Radiation, Pesticides, Poisons, Drugs, Alcohol, Tobacco)

*Learning experiences and student activities correlated with this outline course of study have been developed in resource units and may be secured from the Curriculum Branch, Division of Instructional Services.

II. Populations and Communities

A. Rise and Fall of Populations

B. Limiting and Balancing Factors

C. Succession

1. Plant Populations

2. Animal Populations

III. Ecological Biogeography

A. Physical Environment

1. Temperature

2. Oxygen

3. Solar Radiation

4. Others

B. Biotic Environment

1. Predation

2. Saprobism (Saprophytes, Scavengers, Decomposers)

3. Symbiosis

a. Parasitism

b. Commensalism

c. Mutualism

C. Principles of Distribution

1. Life Zone Concept (California)

2. Bergman's Law, Allen's Law, and Others

3. Biome(s)

   a. Fresh-water

   b. Marine

   c. Forest

   d. Desert

   e. Mountains

   f. Grasslands

4. Biogeographic Realms of the World

UNIT FOUR: CHANGE AND CONTINUITY OF LIFE

The outline of content and concepts for Unit Four are designed to help students develop an understanding of how living organisms are equipped in a variety of ways for coping with their environment. The basic tenet that living things reproduce offspring of their own kind is emphasized in this unit.

Class members will learn that all life on earth, whether it is living or extinct, has descended from pre-existing life. Basic understandings of the mechanisms of heredity, gene pools operating in populations, and the effect of mutations are stressed in this unit. Emphasis is also placed on concepts concerning chromosomes, their molecular structure, and the chemical nature of heredity; and important historical ideas on how living things change. Students will have a more complete picture of the living world around them at the conclusion of this unit.

Estimated teaching time: 4-5 weeks

UNIT FOUR: CHANGE AND CONTINUITY OF LIFE

CONCEPTS TO BE DEVELOPED

Mitosis is the regular division of a cell, in which each of the two daughter cells receives exactly the same number and same kind of chromosomes that the parent cell had.

Each mitotic division is a continuous process; each stage merges into the next one.

Constancy of chromosome number in cells of successive generations of living organisms is assured by meiosis.

Meiosis is a process in which the chromosome number is reduced to one half, or monoploid.

Asexual reproduction is characterized by the presence of a single parent that splits, fragments, or produces spores so as to give rise to two or more offspring.

Sexual reproduction is a fusion of two nuclei from different cells into one cell (zygote).

Among vertebrates, a wide assortment of accessory structures has evolved to aid the union of the sperm and egg and to assure the development of the embryo.

The primary germ layers give rise to all the tissues and organs of the living animal.

Each cell of every organism of a given species contains a characteristic number of chromosomes.

Heritable continuity of life is maintained by the chromosomes and their corporate genes.

Chromosomes contain nucleic-protein complex which both replicate themselves and cause enzyme synthesis.

Hereditary continuity and variability are governed by fundamental genetic mechanisms in accordance with the laws of probability.

Living organisms on earth today represent the current time segment in a continuing process of change called organic evolution.

Natural selection, acting upon the variety of offspring and upon gene mutations for generation after generation, may result in new varieties or species of organisms.

A mutation is any inherited change not caused by segregation or by the normal recombination of unchanged genetic material.

Any population with a common ancestry is likely to have about the same percentage of each generation showing each hereditary trait--population equilibrium.

Survival capacities of a population result from general plasticity of that population.

Adaptive radiation is a form of evolution of a single ancestral species into a variety of forms which occupy many different habitats.

Evolution does not proceed at the same rate among different types of organisms.

Evolution occurs rapidly during times a new group first appears, and then gradually slows down as the group becomes established.

Evolution is not always from the simple to the complex.

Evolution is characteristic of populations, not by individuals, secured through the processes of mutation, recombination, natural selection, and genetic drift.

UNIT FOUR: CHANGE AND CONTINUITY OF LIFE

OUTLINE OF UNIT CONTENT*

I. Continuity of Life

- A. Cell Reproduction
  - 1. Mitosis
  - 2. Meiosis
- B. Asexual Reproduction
- C. Sexual Reproduction
- D. Embryology
  - 1. Differentiation
  - 2. Growth Patterns

II. Patterns in Heredity

- A. Chromosome and Heredity
- B. Nature of the Gene
- C. Reproduction of Genetic Material and Gene Action
- D. Mechanism of Heredity

III. Changes in Living Things

- A. Mechanism of Evolution
  - 1. Early Ideas (Aristotle, Lamarck, and Others)
  - 2. Natural Selection (Darwin, Wallace, and Mendel)
  - 3. Genes and Population (Speciation)
  - 4. Mutations (De Vries)

*Learning experiences and student activities correlated with this outline course of study have been developed in resource units and may be secured from the Curriculum Branch, Division of Instructional Services.

5. Adaptive Radiation and Convergence, Parallelism (Survival Factors)

   a. Food Getting

   b. Mimicry

   c. Hibernation and Aestivation

   d. Migration

   e. Coloration and Camouflage

   f. Mating and Nesting

B. Evidence of Evolution

   1. Extinction and Replacement Theory

   2. Embryology

   3. Vestigial Organs

   4. Industrial Melanism (D.D.T. Resistance, Antibiotic Resistance, and Others)

   5. Geologic Time Table and Fossils

      a. Archeozoic

      b. Paleozoic

      c. Mesozoic

      d. Cenozoic

C. Changes in Primates

   1. Primate Background

      a. Physical Environment

      b. Biotic Environment

PATTERNS IN TEACHING METHODS

CLASS DISCUSSION "When the teacher teaches less, the learner learns more." --Comenius

Stimulating class discussion encourages an exchange of ideas. This teaching method, very often the most commonly used, can be employed as an introduction to demonstration. It will help to create a climate for increased participation, to maintain a high level of interest, and to achieve the intellectual involvement of all the students.

Effective class discussion is developed from skillful questioning. Stimulating students to a period of "problem-asking" very often leads to the development of new ideas and the organization of thought processes. Desirable questioning techniques tend to arouse attention and excite interest. The atmosphere which is created may help to keep the entire class alert. It encourages opportunities for all students to be able to propose a possible answer even though they may not be selected to respond.

It has been pointed out that:

> "The most effective questions are those related to the pupils' lives, which cause them to recall, weigh, and apply prior experience and knowledge. A learning situation occurs almost any time we focus the students' attention upon a problem with which they identify, or challenge a concept the students adhere to."[1]

Basic questioning techniques are suggested by Brandwein, Watson, and Blackwood.[2] The following have been adapted from their suggestions:

1. The teacher begins questions with "What," "Why," "How," and "Where," but rarely with the phrase, "Could you tell us?" or "Who will tell us?"

2. The teacher asks questions in logical sequence, building toward the development of a concept. What information or data do we need to continue our study?

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[1] Paul F. Brandwein, Fletcher G. Watson, and Paul E. Blackwood, Teaching High School Science: A Book of Methods (New York: Harcourt, Brace, 1958), p. 131.

[2] Ibid., pp. 132-134.

3. Questions can serve a variety of purposes:

   a. Eliciting information to clarify a point

   b. Encouraging comparisons

   c. Encouraging analysis and the formation of new subgroups of attributes or reactions not previously recognized

   d. Encouraging generalizations

   e. Encouraging exploration of hypothesis as to whether it suggests or accounts for additional facts or reactions not among the original data used

4. The teacher asks questions that are varied in difficulty. Some are asked of more able students, and other questions are geared to students who are less capable.

5. The teacher not only accepts responses to his questions from volunteers, but also stimulates participation by more passive members of the class.

6. The teacher does not answer questions from students but directs them to other members of the class.

7. The teacher recognizes that an inaccurate response by a student requires further questioning to help him revise his thinking so that an accurate response will result.

8. The teacher questions students who provide accurate responses. "They milk the answer dry of meaning, as it were, and often the youngster is full of wonder as his original response grows in meaning."[1]

9. The teacher directs questions to the entire class in the manner described in the following example:

   > "Why would a person under the influence of alcohol be more likely to suffer from frostbite when exposed to extreme cold than a person who is not under the influence of alcohol? (Pause) JIM?"

   This pause holds the attention of the class and encourages each student to think about the problem before a particular person is called upon to respond.

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[1]Brandwein, Watson, and Blackwood, op. cit., p. 134.

PATTERNS IN TEACHING METHODS

THE DEMONSTRATION

There are times when nothing but the demonstration will do, for example, when the teacher wishes:

To begin a lesson and demonstrate a phenomenon at variance with ordinary experience (e.g., a balloon sticking to the chalk-board, by electrostatic attraction).

To end a lesson leading to an extension of work at home (e.g., just a few minutes before the bell is to ring ending the lesson, he begins testing foods with litmus--oranges, lemons, etc.--the bell rings and he wonders aloud who would finish this at home and report to the class).

To develop a point during the lesson (e.g., students are discussing the difference between a single animal cell and a single-celled animal; at a suitable point the teacher switches on a bioscope or microprojector or film to show a paramecium and a cheek cell).

To highlight safety procedures in the laboratory (e.g., the first time students work with glass, the instructor needs to demonstrate how to insert glass tubing into a rubber stopper, how to bend glass, etc.).

To demonstrate processes generally too dangerous or too complex for students to handle (e.g., the Thermit process, the reduction of CuO, the dissection of an embryo pig, the first experience with circuitry in an oscillator).

To demonstrate additional aspects of laboratory work (e.g., it may not be desirable to have students do all types of preparations of, say, oxygen; one or more procedures might be demonstrated).

For whatever purpose the demonstration is used, its major function is to present evidence for a concept by doing, seeing, testing.

Who does the demonstration? The class; every student participates, in one way or another. The demonstration is part of the lesson; as such, it would be wasteful to lecture as it is being done. For instance, one teacher presented the routine preparation of oxygen in a general science class as follows:

1. Students set up the apparatus (they had read beforehand).

2. The teacher asked these questions:

   a. What substances are we to use? (The student who replied added the materials.)

   b. What is the equation for the reaction? (A student wrote it on the board.)

   c. How shall we proceed? (The students told the teacher, who added appropriate cautions on safety procedures.)

   d. How shall we collect the gas?

In the interim between these questions students watched and took notes. The next day they went to the laboratory, and prepared oxygen according to the procedure they had watched. They then spent the rest of the double-lab period testing the properties of oxygen by procedures they had read about in their text and in a supplementary chemistry text.

A demonstration, in short, may be considered a group experiment in which selected members actually do the experiment, while all observe carefully and suggest procedures, devices, controls, and safeguards. All students take notes; all are expected to use, in future work, the knowledge gained.

The demonstration is not, of course, a substitute for the laboratory.[1]

[1]Brandwein, Watson, and Blackwood, op. cit., pp. 476-77.

PATTERNS IN TEACHING METHODS

THE LABORATORY

"The experiment serves two purposes, often independent one from the other; it allows the observation of new facts, hitherto either unsuspected, or not yet well defined; and it determines whether a working hypothesis fits the world of observable facts" ...Rene J. Dubos

The laboratory teaching method permits the student to have first-hand experiences which enable him to feel the "thrill of discovery." The student is better able to comprehend basic concepts in biology, and he may be able to retain them more effectively than if they were explained by the lecture method. Students learn laboratory skills and techniques through active participation.

In addition, the student recognizes the value of safety rules and regulations during the laboratory period. He also learns about equipment--what it is, where it is located, and how to use it--and about collecting and using recorded data. "An experiment worth doing is one worth recording."

Through the laboratory teaching method, class members learn how to

1. Observe by such activities as

    a. Using a microscope
    b. Performing a dissection
    c. Learning and labeling names of specimens

2. Investigate by planning, devising, and designing a series of experiments to study the solutions to a particular problem

The steps listed below are generally considered as an effective introduction to laboratory activities (scientific inquiry).

1. Students are asked to identify, state, or formulate a problem or problems. During regular class discussion, students have reached the "problem-asking stage." The skillful teacher guides the entire class into identifying a <u>particular problem</u> for study in the laboratory. It may be correct, then, to say that the students state the problem.

2. Discussion of ideas and theories are screened for further consideration.

3. Demonstration and design of experiments that will confirm or disprove proposed ideas are performed by several members of the class.

4. Information gained from specially designed experiments are correlated and evaluated.

5. The skillful teacher guides students into forming conclusions based on significant experimental data.

The types of laboratory experiments have been aptly categorized by Brandwein, Watson, and Blackwood as follows. Students learn to:

1. Use burners, balances, and microscopes--first in relation to work outlined in laboratory instructions and then in relation to an experiment plan.

2. Use the laboratory in recreating classic experiments; this is a "looking over the shoulder of the scientist" method.

3. Gain additional knowledge by varying a standard experiment, but following along "original" lines.

4. Be stimulated to perform an original experiment or project. This activity may involve several days, weeks, or months and is limited as a method by availability of classroom space. Many such experiments are the beginning of a Science Fair project and can be completed by the student at home.

The laboratory lesson requires careful organization and planning. Generally, students will undertake investigations on an individual basis. Each student has the entire responsibility for an experiment and must be able to draw some conclusions when it is completed. They develop attitudes of cooperation and habits of self reliance. Students should be allowed to work in pairs or small groups. Group work aids in creating an atmosphere conducive to the exchange of ideas during an exercise.

Whether laboratory investigations are conducted <u>individually</u> or in <u>groups</u> will depend upon the availability of materials and equipment. Groups may perform the same experiment or simultaneously conduct different experiments to achieve a common goal. <u>Some suggestions for organizing teams or groups for laboratory work are listed below</u>.

1. Teams of students are more effective when they consist of two students or multiples of two. The membership of a team should never exceed eight, because a number larger tends to destroy the unity of the working group.

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[1]Adapted from Brandwein, Watson, and Blackwood, <u>op. cit.</u>, pp. 486-87.

2. Student tables, if movable, can be placed together in varying cluster patterns to form each group's position or "station." If the tables are not movable, certain areas of the room should be designated for each team station. The stations may be numbered for identification by teacher and students.

3. Selection of group or team members may be based on a variety of methods, such as sociometric evaluation, seating arrangement, common interests, and academic levels.

4. The teacher or team members may select the team leader. Such qualities as the following should be considered in making the choice:

   a. Leadership ability
   b. High interest in the subject field
   c. Knowledge of work to be performed
   d. Ability to conduct experiment

5. The team leader has the responsibility of assigning individual members to perform various parts of the experiment. He may also organize and collect materials, guide and direct the activities of the entire team, and be responsible to the teacher directly (if this condition is decided upon by the class).

6. Materials and equipment to be used by the team should be organized in such a way that their distribution and return can be conducted efficiently and quickly at the beginning and end of the period.

7. "Tote" trays or "shoebox" kits are frequently used. Each kit is conspicuously identified and contains a written inventory of its contents. The team leader checks the contents of the kit with each team member. He determines the items to be added or replaced.

8. Chemicals should be clearly labeled, safely stored, and dispensed by the teacher, the laboratory assistant, or a team member.

9. Equipment that will be used frequently should be located in an easily accessible area.

10. Adequate time should be allowed for the orderly return of supplies and equipment. The team leader and his members should reassemble the materials in the kits and return them to their proper storage place. The class and teacher should determine the clean-up schedule at the beginning of the period. All members of the class share the responsibility of washing glassware, throwing away litter, cleaning and wiping tables, and generally putting the laboratory back in order.

Students should be impressed with the following rules of conduct and procedure for laboratory activities:

1. Follow all safety precautions; learn the locations and uses of safety equipment, especially the fire extinguisher and fire blanket.

2. Study the description of the laboratory experiment carefully before attempting the investigation. If you are in doubt about any step in the procedure or any part of the experiment, be sure to consult the teacher before endangering yourself or other team members.

3. Stop and listen carefully to the teacher if he feels that it is necessary to talk to the group.

4. Assure yourself that all laboratory materials have a secure resting place. Do not set apparatus near the edge of the table and reach over it while working. Much of the equipment is expensive. You should exercise great care in its use. "Fooling around" has no place in the laboratory. One careless move may mean the loss of valuable material.

5. Do not hurry through your preparations.

6. Keep your work space clean, and orderly. Do not allow a lot of materials to accumulate on your desk or at your "station." Allow yourself sufficient working space. Orderliness avoids confusion and waste of time.

7. Learn to work quietly. Do not disturb others, especially when they are conducting an experiment. (Students are eager to perform laboratory experiments. There will be noise and more activity than during a "normal" class lesson. Students can talk, but it is the responsibility of the teacher to assure that the noise is constructive and applies to the work at hand.)

8. Learn to stay with your team. Do not roam around the room disturbing other teams.

9. Remember that accurate record keeping is one of the most important phases of your laboratory investigation. Learn to keep your records in a permanent "DATA BOOK" with a hard cover. Be sure to include the date and time of each observation made. Sketches and drawings should be included to provide more specific information when needed.

PATTERNS IN TEACHING METHODS

FIELD TRIP

"Going to see is an important part of any effective science program. Potentially, it is one of the most enjoyable and instructive ways to learn."[1]

The conduct of a field trip is probably one of the most difficult teaching methods to utilize successfully. Nevertheless, it provides a rich experience that cannot be duplicated in the classroom. A certain amount of resistance to "field tripping" may have been experienced by most science teachers. This feeling may be attributed to the danger of accidents, the fact that the trip may take more than one period, and possible disruption of administrative procedures. However, the teacher can reduce or eliminate possible disadvantages through careful planning. Planning the field trip by students and teacher will give a greater purpose to the project as a result of its being a shared responsibility. Some purposes of a field trip for a biology class are:

Clarify and add to information through first-hand experiences

Strengthen the instructional program

Increase understanding of community activities and resources

Build attitudes of civic responsibility

Develop appreciation of community resources[2]

The following outline will guide the science teacher in assuring the success of field trips:

I. Preparation

A. Teacher preparation for a regular school journey

1. Select the school journey you desire from catalog[3]

2. Obtain the approval of your principal

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[1]Glenn O. Blough, et al., Elementary School Science and How to Teach It (New York: Holt, Rinehart, and Winston, 1958), p. 33.

[2]It's Worth A Visit, Catalog of School Journeys for Secondary Schools (Los Angeles City Schools: Division of Instructional Services, Publication No. SC-460, 1960), pp. vi-vii.

[3]Ibid., pp. 10-11.

3. Call the Transportation Branch at RIchmond 7-4411, Ext. 466, following procedures outlined in catalog.[4]

4. If possible, make the visit yourself prior to the date of the class journey

B. Student preparation

1. Distribute Form 34-EH-17, "Parent's Approval," to students and set a deadline for its return. Distribute "Activity Excuse Form" for classes from which pupils will be absent.

2. Request help in supervision, if necessary, from parents or P.T.A. (Parents must furnish their own transportation.)

3. Motivate students for the field trip. Relate things to be seen on field trip with unit being studied.

4. With the class, establish objectives of the trip. Explain the type of evaluation which will be required.

5. Develop standards for safety and behavior during the entire school journey. Be sure that students understand the host-guest aspects of the trip.

6. Plan with students the things that they will need to bring, including lunches.

II. The Trip -- Directed Observation

The teacher is responsible for the supervision of the students at all times. If no guide is provided, the teacher must be well-informed regarding the details of operations or the nature of the display.

A. If a guide is provided by the organization being visited, provide him with a clear idea of the purpose of the tour.

B. Inform the guide of any questions formulated by the class prior to the excursion.

C. Place members of the group in a manner so that all may hear the guide and see the operations or processes.

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[4]Ibid., p. 2.

D. Permit note-taking and sketching by pupils if time is available.

III. The Follow-Up

A. Discuss after the trip such things as:

1. Questions listed before the trip and answers obtained.

2. Contributions of the trip to the unit being studied.

3. Behavior of the class during the trip.

B. Engage in follow-up activities, such as:

1. Search for more information.

2. Oral or written tests.

3. Collection of materials, such as sea shells, plants, insects.

4. Use of related materials from home.

5. Use of audio-visual materials.

C. Evaluate the school journey for such values as:

1. Expanded student contact with community activities.

2. Development of keen and accurate observation.

3. Retention of the information received.

4. Enrichment of the unit of study.[1]

[1] It's Worth A Visit, op. cit., pp. 10-11.

PATTERNS IN TEACHING METHODS

THE CASE STUDY

The case study as an approach to teaching science is dependent on (1) the selection of specific scientific ideas or principles and (2) the use of a historical treatment to show how a major scientific idea or generalization evolved as a result of the work of many scientists or investigators.

The historical development of events and activities that led to the formulation of a basic scientific idea is emphasized by the case study method, rather than an application, such as the invention of a motor, the electric iron, or the toaster. The information that is usually obtained from readings in a case study approach is of an esoteric nature. Since different ideas are postulated as a result of other experiments, some of the earlier information reported in the literature may be incorrect. Therefore, careful guidance in the use of the case study method is suggested. Perhaps some teachers may wish students to evaluate older ideas in comparison with recent experiments.

There are some very basic scientific attitudes that can be taught via the case study approach. One important attitude is the search for knowledge as an intellectual and worthy endeavor even though no application or money-making gadget is made... Other attitudes such as perserverance or stick-to-itiveness may also be reflected as one reads the great discoveries in science.[1]

James B. Conant, one of the leaders in science education, has called this approach "looking over the shoulder of a scientist at work." In his book On Understanding Science, he observed that:

I would choose case histories for my projected course from as many areas in the whole field of accumulative knowledge as possible, insisting only that three criteria should be met: (1) The field in question must be one in which there can be no doubt that progress has been substantial in the last century or so (and my test would be the imaginary operation of invoking the judgment of the past). (2) This progress must be in terms not of practical achievements or mere amassing of data but in terms of changing concepts and evolving conceptual schemes, the result of experiment or observation, yielding in turn new experiments and observations. (3) One or more of the principles common to the tactics and strategy of science must be conveniently illustrated by a study of the case.

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[1]Nathan S. Washton, Science Teaching in Secondary Schools (New York: Harper, 1961), pp. 226-28. Reprinted with permission of Harper and Row, Publishers, Incorporated.

> Each case study is built around significant sections from the original writings of the scientists involved. There is an analysis of the historical background behind each investigation and a painstaking account and analysis of the investigator's purpose, his way of recognizing the problem, his grand and limited working hypothesis, his experimental design, his techniques, his errors, and his difficulties.
>
> The essential way of dealing with the case study is to have students read it before class, then 'milk it dry' with a discussion of the ways of the scientist under scrutiny.[1]

The teacher will find the following references to be helpful in use of the case method:

Harvard Case Histories (available in pamphlet form), Yale University Press, Cambridge, Mass.:

James B. Conant, Robert Boyle's Experiments in Pneumatics

_____ , The Overthrow of the Phlogiston Theory

_____ , Pasteur's Study of Fermentation

_____ , Pasteur's and Tyndall's Study of Spontaneous Generation

L. K. Nash, The Atomic-Molecular Theory

_____ , Plants and the Atmosphere

Duane E. Roller, The Early Development of the Concepts of Temperature and Heat

D. E. Roller and D. H. D. Roller, The Development of the Concept of Electric Charge

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[1]James B. Conant, On Understanding Science (New American Library, Mentor Book. New York: Yale University Press, 1953), p. 38.

W. I. B. Beveridge, Art of Scientific Investigation. Revised Edition. New York: W. W. Norton, 1957.

I. B. Cohen, Science, Servant of Man. Boston: Little, Brown, 1948.

L. Klopfer, and F. G. Watson, "Using Historical Materials in High School Science Teaching," The Science Teacher, Vol. 24 (1957), p. 264.

F. Sherwood Taylor, A Short History of Science and Scientific Thought. New York: W. W. Norton, 1949.

SAFETY RULES AND REGULATIONS

Teachers cannot place too much emphasis on assuring that students observe safety rules and regulations in science classrooms. As each demonstration or laboratory activity is planned, safety precautions should be considered in setting up and handling materials and equipment. Most accidents can be prevented if reasonable precautions are taken. Some of the following regulations are intended to call attention to the necessity of observing all precautions.

CLASSROOM LABORATORY

Notify the principal at once of any safety hazard that develops in the room, such as defective gas and electric outlets and connections, defective seats that may cause injury, and defective fire extinguisher.

Request that fire extinguisher be inspected at least once during each term by the proper authorities.

Perform all experiments at a safe distance from students.

Do not permit students to carry apparatus through the halls when classes are passing.

Supervise students carefully when they are using sharp-edged instruments.

Instruct students never to "short circuit" dry cells or storage batteries.

Instruct students never to grasp any electrical device which has just been used. Most electrical devices are hot after use, and serious burns can result if device is touched before it cools.

Examine all electrical setups before they are used by students.

USING HEAT

Do not allow students to perform any experiments involving the heating of alcohol, strong acids, or strong bases.

Never bring gasoline, ether, carbon disulfide, alcohol, or other volatile, inflammable liquids near a flame.

If alcohol ignites in a beaker, cover it with a glass plate to extinguish flame. If burning alcohol runs over table, use fire blanket.

Instruct students never to point the mouth of a test tube toward their faces nor toward their neighbors while the test tube is being heated.

Instruct students never to heat a completely stoppered container.

Instruct students never to pass a hand or arm over a lighted burner.

USING GLASS

Do not allow students to cut, manipulate, or use glass tubing unless they have received precautionary instructions.

Instruct students never to attempt to insert glass tubing with a jagged end in a rubber stopper. They must first fire polish the tubing.

Point out that students must use water, soap, glycerine, or some other lubricant before forcing glass tubing into rubber stoppers. Tubing must always be aimed away from palm of the hand which holds the stopper or rubber tubing.

Emphasize that students must always hold glass tubing as close as possible to the part where it is entering the rubber stopper to protect hand. A cloth wrapped around the hand or tubing at the point of contact will help avoid injury if the glass breaks.

USING CHEMICALS

Make certain that all combustible and dangerous materials, such as poisons and acids, are kept securely locked in a metal cabinet and that students do not have access to such a cabinet.

Place large storage bottles of acids and other dangerous chemicals on the floor of the cabinet.

Handle concentrated acids and alkalies with extreme care.

Never place bottles containing acids or organic volatile liquids near heat or allow them to stand in the sun. Otherwise, dangerous gas pressures may be built up.

Do not use the following materials for experimentation or demonstration:

Phosphorous (red, white, or yellow)
Metallic sodium
Concentrated acids
Materials capable of generating poisonous gases
Hydrogen gas
Potassium chlorate
Other materials subject to explosion

Never add water to concentrated sulphuric acid. Dilute acids should be prepared by adding small quantities of concentrated acid to water. During this process, the solution should be stirred constantly.

ANIMALS IN THE CLASSROOM

Instruct students to handle laboratory animals with great care and only under the supervision of the teacher so that the danger of their being bitten may be avoided. Heavy gloves should be used if there is any possibility that an animal will bite.

Caution students not to insert fingers in the wire mesh of cages. Place appropriate warning signs on cages, such as "KEEP HANDS OFF." and "DO NOT HANDLE."

If student is bitten by a laboratory animal, notify the school nurse. Ask the health coordinator or principal for further directions.

DO NOT KEEP POISONOUS SNAKES IN THE SCIENCE ROOM. Discourage students from bringing poisonous snakes or insects into the classroom laboratory.

ANIMAL CARE ACT

To conform with the provisions of the Animal Care Act, be sure that all warm-blooded animals kept in science rooms are cared for in the following manner:

1. These animals are to be kept for observational purposes only, and no experimentation affecting the health of the animals will be conducted.
2. The animals are to be kept in clean, comfortable cages.
3. They are to be fed and watered daily during school days, and sufficient food and water are to be provided for Saturdays, Sundays, and holidays if they are left on the school premises.

4. The cages are to be cleaned periodically by scrubbing with boiling water and disinfectant.

EXPERIMENTS INVOLVING STUDENT'S BODY

Permit wood splints, blunt instruments, or flat wood toothpicks to be used when students secure epithelial cells from inside the cheek. Never permit them to use a scalpel or any other sharp instrument.

Survey students to determine whether any may have a known prolonged bleeding time (include in this survey diabetics and partial hemophiliacs).

Do not allow students with known prolonged bleeding time to participate in blood-sampling activities.

Before blood sampling experiments are conducted, have on file a signed parent approval form for every student involved in the activity. See sample form.

Direct students to use only a sterile disposable lancet in conducting a blood-sampling activity.

Do not permit more than one student to use the same lancet under any circumstances.

Be sure that sterile methods are employed before, during, and after a blood-sampling activity

USING RADIOACTIVE MATERIALS

"For the teacher who will utilize radioisotopes for only a few days during the teaching year, the important consideration is to assure the administration and the community that the proper precautions for handling radioisotopes are known and are being carried out efficiently."[1] All radioisotopes must be purchased through the Science Center. If the general rules listed below are followed, there is no reason why any of the microcurie quantities available should offer any hazard.

All work with unsealed radioisotopes should be performed in trays. Any spills will be confined and can readily be decontaminated.

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[1]United States Atomic Energy Commission, Teaching With Radioisotopes (Washington, D.C.: U. S. Government Printing Office, 1959), p. 18.

Rubber gloves should be worn when handling active solutions. The use of tongs and other devices to keep materials from direct body contact is desirable.

Where vaporization may occur, the operations should be done under a fume hood.

Pipetting of radioactive solutions by mouth should not be performed. Suction bulbs, spit traps, or other similar devices must be used.

Eating, drinking, smoking, and use of cosmetics should not be allowed where radioactive materials are present.

All contaminated disposable materials should be placed in a labeled container for subsequent disposal.

All glassware used for radioactive solutions should be kept separated from noncontaminated glassware.

Hands should be washed after working with active solutions, and the hands, clothing, and area monitored[1] as a standard procedure.

Radioactive materials should be plainly labeled and stored in a locked cabinet or room when not in use.

A sign indicating that radioactive materials are being used should be displayed during any exposed experiment.

No protective clothing beyond the usual laboratory clothing is necessary in working with unlicensed quantities of radioisotopes.

All radioactive materials received, disposed of, or stored must be accounted for. The teacher should record the date of receipt, amount of order, and date and location of disposal for the information of the department chairman.[2]

The teacher should assure that no more than 30 microcuries are stored in a single school at one time. He should report the amount being used to the department chairman so that it will not exceed the authorized maximum.

To reduce to a minimum the quantity of radioactive materials which must be kept on hand, it is suggested that teachers schedule instruction at different times so that the same materials can be shared.

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[1]The amount of ionizing radiation or radioactive contamination present in an occupied area should be determined periodically or continuously as a health safety measure.

[2]United States Atomic Energy Commission, op. cit., p. 18.

The student will be required to study, sign, and obtain parents' signature on form for safety regulations in laboratory for Biology 1 and 2.

See sample below

LOS ANGELES CITY SCHOOL DISTRICTS

_____Senior High School

SCIENCE LABORATORY REGULATIONS
BIOLOGY 1 AND 2

The following regulations have been compiled for the safety of students participating in laboratory activities in Biology 1 and 2 classes. Strict observance of the regulations is required.

Please read the following with care, sign the statement below, and return to the instructor before beginning work on any laboratory activity. Keep the copy of the regulations in your loose-leaf notebook for future reference.

GENERAL RULES OF CONDUCT

1. Remember that an instructor must be present during all laboratory work.
2. Perform all experiments carefully and in such a manner as to assure the safety of all persons.
3. Follow directions exactly as stated.
4. Perform ONLY those experiments specifically approved by the instructor. Unauthorized experimentation will not be permitted.
5. Be sure to protect your clothing and the surrounding work area from chemicals.
6. In case of any accident, report to the instructor AT ONCE.

HANDLING OF EQUIPMENT

1. Be sure that all containers, such as test tubes, beakers, and flasks, are clean before they are used. Material left in containers from a previous experiment may cause errors in new experiments or result in dangerous reactions.
2. Never force glass tubing into or out of stoppers. Always lubricate stoppers with water or vaseline before fitting the glass. Protect your hand from the glass when inserting it by wrapping a paper towel or cloth near the end to be inserted. Use a twisting motion.
3. Before cutting, heating, or bending glass tubing, obtain instructions from the instructor.

4. Before heating any apparatus, be sure that all outlets are open.

5. Never point the mouth of a test tube toward your face or toward your neighbor while you are heating it.

6. Always slant a test tube when heating it. Apply heat along the side of the test tube, not just at the very bottom.

7. When heating volatile materials, use an electric hot plate or water bath. Never use an open flame.

8. Do not reach over an open flame. Turn Bunsen burner off when not in use.

9. Never drink out of laboratory glassware.

HANDLING OF CHEMICALS

1. In case of a burn from an acid or alkali, wash the affected area immediately with plenty of running water; then report to the instructor at once.

2. Never add water to an acid. Instead, cautiously add acid to the water while stirring constantly.

3. Never make explosive compounds.

4. Never taste a chemical or solution unless directed to do so, because poisonous substances are not always so labeled in the laboratory. If you accidentally swallow any chemical, report at once to the instructor.

5. When noting the odor of any liquid, do not put your face directly over the container. Instead, fan a little of the vapor toward you by sweeping your hand over the top of the container.

6. Dispose of all waste chemicals as directed by the instructor. Never return unused chemicals to supply containers.

7. Use great care when working with ether or chloroform in fruit fly examination. Open windows and doors to assure the greatest possible ventilation. Be sure that receptacles containing chemicals are closely capped.

HANDLING OF WARM-BLOODED AND OTHER ANIMALS

1. Never handle warm-blooded animals in the laboratory unless directed to do so by the instructor.

2. Never insert your fingers or hands in the wire mesh of animal cages to poke or pet warm-blooded animals. (This rule also applies to any other animal in the classroom.)

3. Notify the instructor <u>at once</u> if you are bitten.

4. Never bring poisonous animals to school, such as snakes and spiders.

HANDLING OF RADIOISOTOPES

1. Perform experiments involving radioisotopes only when closely supervised by the instructor.

2. Never handle radioisotopes unless directed to do so by the instructor.

3. Never pipette radioactive solutions by mouth. Use a pipette control device, rubber bulb, or medicine dropper.

4. Avoid inhalation or ingestion of radioactive materials.

5. Avoid contamination of hands with radioactive materials. Wash hands with soft brush and soap for several minutes after working with radioactive materials.

6. Only dispose of the radioactive materials used in laboratory experiments under the direction of the instructor. Never throw radioactive materials into wastepaper baskets, or pour radioactive liquids down the sink drain.

CONDUCT OF BLOOD SAMPLING

1. Obtain signature of a parent on approval form for blood-sampling experiment and place it on file with the instructor.

2. Never participate in blood-sampling activity if your blood clotting time is known to be slower than average.

3. Always wash hands with soap and water before attempting a blood sampling.

4. Sterilize skin with alcohol swab before blood sampling.

5. Use only a sterile disposable lancet for obtaining a blood sample. Never use lancet more than one time. Under no circumstances should lancet be used by more than one person.

6. Always sterilize skin with alcohol swab after blood sample has been obtained.

HANDLING OF BACTERIA

1. NEVER OPEN petri dishes containing bacterial growth unless directed to do so by the instructor.

2. Dispose of all discarded bacterial cultures or by using as directed by the instructor through sterilization, using steam, or by using creosol, lysol, or boiling methods.

THESE REGULATIONS ARE TO BE FOLLOWED BY STUDENTS IN THE LOS ANGELES CITY SCHOOLS AND TAKE PRECEDENCE OVER ANY CONFLICTING INSTRUCTIONS IN TEXTBOOKS OR LABORATORY MANUALS.

LOS ANGELES CITY SCHOOL DISTRICTS

_____Senior High School

PARENT'S OR GUARDIAN'S STATEMENT

I have read the foregoing safety regulations for students performing laboratory activities in Biology 1 and 2 and hereby pledge my cooperation in urging that

_____ observes these instructions
Name of Student

set forth for his protection.

_____ _____
Signature of Parent or Guardian Date

STUDENT'S STATEMENT

THIS IS TO CERTIFY that I have read the Science Laboratory Regulations as prescribed by the Los Angeles City Schools, and hereby agree to abide by them in the performance of all experiments in Biology 1 and 2.

_____ _____
Signature of Student Date

_____ _____
Address Telephone No.

EVALUATION

In evaluating student progress during Biology 1, the teacher will seek to determine how well course objectives have been accomplished. This appraisal should concern not only mastery of content but also such other outcomes as growth in critical thinking, development of attitudes of the scientist, and understanding of cause and effect relationships. Certainly, measurement of progress of this type will be more difficult than determining the degree to which students have mastered facts.

It is not the intent of evaluation to minimize the importance of factual information, but rather to emphasize the achievement of goals directly related to life needs and interests. Therefore, it is suggested that evaluation stress the following:

To devise tests and other forms of measurement that will reveal mastery of facts and functional understandings of the concepts and generalizations involved.

To devise techniques for revealing growth toward the original objectives which have been established.

Evaluation of mastery of facts and functional understandings may be accomplished by means of teacher-prepared tests and standardized tests. On the other hand, measurement of achievement of other course objectives is subjective and difficult to administer. Teacher judgments based upon observation of student performance will take into consideration what students do in the classroom and laboratory and what they say, write, produce, and read.

ORDERING PERISHABLE MATERIALS FROM THE SCIENCE CENTER

The Science Center, located at 1205 West Pico Street, provides essential services and facilities for science teachers. Perishable laboratory materials and special equipment for classroom use are available upon order from the Science Center.

Each senior high school is allotted funds on a yearly basis for purchase of perishable materials from the Science Center. These allocations are in addition to any other funds available to the science department of the school.

The science department chairman fills out the order for the department upon blanks secured from the school secretary. The order is approved by the principal of the school and forwarded by school mail to the Science Center. Orders must reach the Science Center two weeks before the delivery date requested. The Delivery Schedule will contain additional instructions for ordering materials.

Loan items presently available are centrifuge, kymograph, and three and five inch oscilloscopes. Teachers who have attended institutes or in-service training classes which have provided instruction on the use and care of specific items may request loans of the equipment for two-week periods.

Teachers who order radioisotopes P^{32} and I^{131} for classroom laboratory investigations must have had some previous experience with the handling of such materials.

AUDIO-VISUAL MATERIALS

"The teaching of science depends upon materials that we can see, hear, feel, smell, and taste."[1] The science teacher should make use of a great variety of audio-visual materials so as to provide many kinds of experiences for students. He should determine what materials will best help to: (1) create vital experiences for the learner; (2) provide an interesting environment; (3) supply resource material; (4) strengthen basic skills; (5) increase understanding; (6) build appreciation; (7) stimulate creative activity; and (8) encourage student participation.[2]

PROJECTIONS

In science teaching, projections help bridge the gap between real experience and abstract words. Listed below are types of audio-visual materials that contribute to instruction.

Motion Pictures

Films stimulate the student emotionally. They provide animation to motionless things, show the continuity of a process, project the student into time and space, build attitudes, and create interest. Films can be used in the classroom-laboratory to:

1. Introduce a topic
2. Review subject matter
3. Provide a vicarious field trip
4. Provide a supplementary demonstration
5. Serve as accessory microscopes or microprojectors
6. Serve as testing devices[3]

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[1]Richardson, Science Teaching in Secondary Schools (Englewood Cliffs, N. J.: Prentice-Hall, 1957), p. 300.

[2]Adapted from Audio-Visual Materials - Secondary Grades (Los Angeles City Schools: Division of Instructional Services, Publication No. 579, 1961).

[3]Adapted from Brandwein, Watson, and Blackwood, op. cit., pp. 479-80.

Excessive use of films destroys their value. A variety of approach in the classroom helps to maintain student interest. The following procedures in the use of films are suggested:[1]

1. The teacher selects the film on the basis of the purposes, needs, and interests of the class.

2. He previews the film and plans the lesson.

3. The teacher and students discuss the film in advance, pointing out what to look for, how to avoid misconceptions, and what new concepts should be learned.

4. The teacher shows the film, after which it is again discussed.

5. Students engage in follow-up activities, such as preparation of written and oral reports, reading related materials, and taking of tests.

For a listing of available films and ordering procedures, refer to the Catalog of Films--Secondary Grades.

Opaque Projections

Opaque projectors are available in most schools and can be used by the science teacher to show pictures, charts, diagrams, and the printed text of books, magazines, and pamphlets. When there is only one copy of a picture or diagram or of other material, showing it by opaque projector will save time, money, and energy. However, a distinct disadvantage of this technique is that the room must be well-darkened. Teacher-made plates covering a variety of topics may be prepared and stored for future use.

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[1]Catalog of Films--Secondary Grades (1962 Edition. Los Angeles City Schools: Division of Instructional Services, Publication No. 530).

Microprojections

Most science departments have available microprojectors. The teacher's use of this equipment makes it possible for the entire class to focus attention on the same microscopic material at one time. In addition, the teacher is able to give his undivided attention to the projected image, describe the object being viewed and lead a discussion concerning it. The teacher is able to locate certain structures or areas that each student should view individually.

Any substance that can be viewed under a microscope by transmitted light can be shown by microprojection. Some suggested materials are plant tissue, animal tissue, various fibers, and crystals of chemical elements or compounds. The best sources are the prepared slides which can be purchased by the science department. A distinct disadvantage of microprojection is that it requires a well-darkened room. Fast-moving protists are difficult to show with a microprojector. Its best use is with groups of not more than eight students. They can view slides projected on a light background on a table even in a normally lighted room.

Filmstrips

Filmstrips have an advantage over films in that they can be viewed on the screen for long periods of time. A single frame can be shown in sequence or out of it. Filmstrips may be used to review, to clarify content, to increase retention, and to create interest. However, they should be carefully previewed by the teacher. In lesson planning, he should give careful consideration to the amount of time available for this purpose. It is seldom desirable to show an entire filmstrip because not all of its contents will be applicable to the lesson. Some points can also be taught more effectively by other methods. Filmstrips enable the teacher to note vocabulary needs, to provide an opportunity for guidance in development of reading skills, and to involve the entire class in the learning activity. Whatever approach is used, the filmstrip should be used in a lesson rather than substituted for a lesson. The teacher should become acquainted with the science department's basic library of filmstrips. For other available filmstrips, refer to the Catalog of Audio-Visual Materials--Secondary Grades.

Slides

In many ways, slides can be used in the same manner as filmstrips. They permit the teacher to select a proper sequence that is most applicable to current study. Teachers will find it helpful to take their own photographs for a particular unit of work. Using the local environment is a subtle way of stimulating students into sharing their own experiences with teacher and classmates by bringing their own slides for class inspection. There are also many excellent photomicrographs in color of tissues and cells that can be viewed in place of microprojections. These photomicrographs can be purchased on the consumable supply (order) requisitions through the science department chairman. See the Catalog of Audio-Visual Materials--Secondary Grades (1961 Edition. Los Angeles City Schools: Division of Instructional Services, Publication No. 579), for listing of 2" x 2" slides available for loan.

RADIO AND TELEVISION PROGRAMS

Viewing of network radio and television programs should be considered as supplementary to classroom work to stimulate further study and activity. If the students enjoy a program and find it stimulating, teachers should consider its inclusion as part of instruction. Skillful teachers will prepare their classes for such broadcasts after assuring that they are enjoyable and can be used as "springboards" to creative activities. The following checklist for successful and effective listening and viewing is suggested:

1. Available information checked for suggestions in using programs
2. Radio or television set ready in front of the room, properly tuned and checked for adequate signal
3. Outside noise and interruptions forestalled
4. Class prepared and comfortably seated in a light, well-ventilated room
5. Relaxed, attentive listening by the teacher as well as the class
6. Time set aside for creative follow-up activities
7. Every opportunity utilized to integrate the content of the program with class instruction

VISUAL TECHNIQUES FOR WHICH PROJECTION EQUIPMENT IS NOT REQUIRED

Flannel Boards

The flannel (felt) board can stimulate the student's imagination with form and color. It is an aid in learning situations that involve the visualization of steps. It also simplifies content and encourages participation in learning. The flannel board technique can be used in introducing a unit, emphasizing subject content, clarifying content, reviewing for a test, and using material during a test.

Specimens

Collections made by the teacher or the student can provide a basis for greater understanding of the environment as related to the life of the individual. Using specimens in a learning situation enables the student to identify interrelationships.

Models and Mock-Ups

Models and mock-ups have been very useful to science teachers for many years. They can be prepared by students for a particular unit of work. Most science departments have available commercially produced models of the torso, ear, eye, kidney, heart, skeleton, and spinal cord (the latter in cross-section). The use of models in science teaching is designed to develop an understanding of simplified structure and function.

Bulletin Boards

"The bulletin board is practically indispensable in the science room. It can be the center of class activities as well as provide for casual display of related material in science."[1] The bulletin board can be used to:

1. Arouse interest in a new unit.

2. Emphasize or reteach some part of a unit.

3. Lead to the next topic to be studied.

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[1]Richardson, op. cit., p. 244.

4. Add beauty and attractiveness to the room.

5. Stimulate many students to assist with preparation of displays.

6. Develop acceptance of responsibility of student chairmen who are placed in charge of bulletin board displays.

Material for bulletin board displays should be carefully selected, interesting to students, pertinent to the topic being studied, and changed often. Arrangement of materials should be based upon sound principles. A diagram or layout of materials should be prepared on a flat surface until a pleasing arrangement has been formulated.

The person in charge of displays should:

Maintain margins.
Maintain a balance of color and of shapes and sizes of materials.
Avoid crowding.
Use straight pins or map tacks to secure the four corners of each item.

Pegboards

Displays in science classes can be exhibited easily by using a pegboard. Pegs or wire hooks inserted in the holes will support large pieces of apparatus, specimens, and other objects. Blocks of lettering can be glued onto golf tees and inserted into the holes to produce a three-dimensional appearance.

Titles which are self explanatory or thought provoking should be used with all display material. Simple block letters cut from light pasteboard or construction paper can be saved in envelopes and used again and again.

TRANSCRIPTIONS

Sometimes a simple dramatization of subject matter can be more meaningful to the student than the presentation of information by the lecture method. Professional transcriptions on a variety of topics are available. These include talks by famous scientists,bird calls, and animal sounds. Refer to the Catalog of Audio-Visual Materials--Secondary Grades for a listing of available recordings and transcriptions.

SUPPLEMENT

BIOLOGY 1

A MODIFIED COURSE FOR SLOW LEARNERS

AN APPROACH TO TEACHING THE SLOW LEARNER

Science is so much a part of the lives of everyone that it is of necessity becoming increasingly important in our modern high school curriculum. A course modified to meet the needs and learning level of the slow learner in 10th grade Biology 1 has been developed. The large conceptual schemes for biology are the same as for the regular course but are modified by the depth of concepts and the manner in which the teacher guides the student through the basic content.

Since many of the modern biological concepts require concentration and academic excellence, teachers using this modified outline should be alerted to the general characteristics of slow learners. Slow learners have a short attention span, generally about ten to fifteen minutes in length; show low scores in reading and mathematical abilities; and are readily distracted from their work.

The following guidelines suggested are techniques that have received considerable success in teaching slow learners. The teacher is charged with the responsibility of planning lessons with these guidelines in mind.

1. Emphasize the relationship of science to everyday living.
2. Follow the modified outline and use the resource units minimizing the requirements, such as using the laboratory activities and demonstrations as suggested for average learners but modifying the explanation by using non-technical terms.
3. Limit the number of demonstrations. Spend more time in discussion of those used.
4. Perform demonstrations which are easily analyzed.
5. Use concrete terms...avoid theoretical approaches and the abstract.
6. Remember that slow learners are characterized by a short attention span so there is a definite need for a change of pace during the period.
7. Use a variety of audio-visual aids, always being careful to select only those that are suitable to the learning capacity of the slow learner.
8. Review the content frequently.
9. Ascertain the reading level of the students in your class as soon as possible.
10. Select suitable reading material for the slow learner whenever possible. Create many opportunities for oral reading.
11. Limit the science vocabulary to simple terms, striving to relate as many of the terms to the experience of the student as possible.
12. Create opportunities for students to present their ideas visually through construction work, drawings, and clay modeling.

UNIT ONE: FOUNDATIONS OF LIFE

The outline of content and concepts for Unit One are intended to develop understandings of the physical and chemical nature of living systems. Whether these systems be plant or animal they are shown to be fundamentally similar in function despite of vast differences in structures.

This unit provides for further development of concepts established in the junior high school science program. The world of molecules and atoms that ultimately make up cytoplasm should be emphasized as much as the structure and function of cells. Basic understandings of the origin of life are brought into focus. Recent advances relating to understanding photosynthesis are pointed up in this unit. This unit is, indeed, the foundation for succeeding units.

Estimated teaching time: 6 weeks

UNIT ONE: FOUNDATIONS OF LIFE

CONCEPTS TO BE DEVELOPED

Matter is anything that occupies space and has mass and inertia.

All matter possesses energy in one form or another.

Matter and energy can neither be created nor destroyed, but can be transformed from one into the other.

An element is a substance in which the atoms are all alike.

Molecules are the smallest particles of a substance that can exist in free state and which have all the properties of the substance.

Molecules of all substances are in constant motion.

The cell is the unit of structure and function in living organisms.

All cells come from previously existing cells.

The most important bacteria are those found in the soil and ocean, which cause decay and play an important part in the releasing of nitrogen, and those bacteria which cause disease.

Slime molds show both plant-like and animal-like phases in their life cycle.

Protoplasm is the physical basis of life.

Living cells require food and oxygen for energy and growth and must get rid of carbon dioxide, water, and urea.

The four basic constitutents in the cell's raw materials are carbon, hydrogen, nitrogen, and oxygen.

The energy that supplies all life on the earth come ultimately from sunlight, through the process of photosynthesis.

UNIT ONE: FOUNDATIONS OF LIFE

OUTLINE OF UNIT CONTENT*

I. Overview

A. Living vs. Nonliving

1. Review of Characteristics of Living Things

2. Review of Conditions Under Which Life Can Exist

B. Review of Interrelations of Matter and Energy

II. Chemical Background

A. Structure of Matter

1. Atoms

2. Molecules

B. Physical and Chemical Changes

C. Characteristics of Some Basic Elements

III. Origin of Life

A. Theories

1. Early Ideas

2. Spontaneous Generation

3. Cell Doctrine
(Microscope....a brief history of its beginning and use)

*Learning experiences and student activities correlated with this outline course of study have been developed in resource units and may be secured from the Curriculum Branch, Division of Instructional Services.

B. Units of Life

1. Virus and Rickettsial Bodies

a. Basic Characteristics

b. Virus and Diseases of Plants and Animals

c. Rickettsial Bodies and Diseases of Plants and Animals

2. Bacteria

a. Basic Characteristics

b. Basis of Identification (Shape and Others)

c. Bacteria and the Nitrogen Cycle

d. Bacteria and Disease

IV. Modern Concept of the Cell

A. Shapes and Sizes

B. Structure and Function of Cell Parts

C. Cellular Physiology

1. Necessary Nutrients

2. Gas Exchanges

3. Respiration

4. Utilization of Energy

5. Photosynthesis

UNIT TWO: VARIETY OF LIFE

The outline of content and concepts for Unit Two are designed to help students develop an understanding of the degrees of differences and similarities among living organisms. The background gained in Unit One regarding the cellular level of living things has provided an important basis for development of this understanding.

Students will become more aware of the great diversity among living things. Instruction in Unit Two stresses the system of organization, its early beginnings, and later developments. The diversity of structure, form, function, and development and evolutionary implications are emphasized. Plant and animal organization has been revised to be consistent with modern concepts and with a "natural classification" to reflect the evolutionary history of a group. Students will develop background necessary for the study of the diversity of habitats which will be covered in the next unit.

Estimated teaching time: 3-4 weeks

UNIT TWO: VARIETY OF LIFE

CONCEPTS TO BE DEVELOPED

Homologous structures are structures that are similar and are located in corresponding parts of the bodies of organisms.

Organisms having the same anatomical pattern do belong to the same biologically evolving population.

Members of a species can interbreed and produce fertile offspring.

The basic taxonomic unit is the species.

Classification is an arbitrary method of placing living organisms into orderly groups which are based on structural characteristics.

Plants and animals show a gradual increase in complexity in organization.

UNIT TWO: VARIETY OF LIFE

OUTLINE OF UNIT CONTENT*

I. Basis for Organization

- A. Resemblance (Homology)
- B. Analogy

II. Organization of Living Things

- A. Nomenclature and Taxonomy (Linnaeus and Others)
- B. The System (A Sample Classification)
- C. Overview of Plant and Animal Classification

III. Variety in Animals

- A. Basic Animal Characteristics
- B. Multicellularity
  1. Lower Forms of Animal Life
  2. More Complex Forms of Animal Life

IV. Variety in Plants

- A. Basic Plant Characteristics
- B. Lower Forms of Plant Life
- C. More Complex Forms of Plant Life
  1. Conditions for Land Life
  2. Vascular Plants

*Learning experiences and student activities correlated with this outline course of study have been developed in resource units and may be secured from the Curriculum Branch, Division of Instructional Services.

UNIT THREE: DISTRIBUTION OF LIFE

The outline of content and concepts for Unit Three will develop student understanding of conditions which affect the growth and distribution of living things. Units One and Two have provided the background for this study.

Students will learn that the biosphere, the zone of life over the surface of the earth, is a dynamic system of interlocked living and inorganic processes. This unit also stresses basic understanding of factors in our physical environment, such as temperature, moisture, light, and food, which determine to a great extent why certain forms of life exist in one part of the world rather than in some other part. Also emphasized is the fact that most forms of life are capable of adapting themselves to the conditions of their habitat because of certain modifications in their biological structure. Students develop a perspective of the distribution of life and man's place through the study of concepts concerning the importance of food chains and food webs, chemical cycles in the transfer of energy, and populations and their interactions, from the ecological niche through the biogeographic realms.

Estimated teaching time: 3-4 weeks

UNIT THREE: DISTRIBUTION OF LIFE

CONCEPTS TO BE DEVELOPED

The capture of basic energy is through photosynthesis by producer organisms (green plants or green protists).

The sequence of species through which materials and energy pass is a food chain.

The flow of chemicals circulates in characteristic paths from the environment to organisms over and over again.

Plant and animal communities are interdependent.

When man interferes with the dynamic equilibrium in a natural community, the results may be far reaching and difficult to correct.

Population is a group of organisms of the same or similar species which occupy a given area.

Characteristics of a population are the function of the whole group and not of a single individual. These include population density, birth rate, death rate, rate of migration, rate of emigration, and age distribution.

The maximum and minimum tolerances of an organism limit the kinds of environments in which it can survive.

Soil temperature, and rainfall play a vital role as geographic latitude and altitude vary. These factors tend to divide the soil-surfaced earth into a number of distinct habitat zones: desert, grassland, rain forest, deciduous forest, taiga, and tundra.

UNIT THREE: DISTRIBUTION OF LIFE

OUTLINE OF UNIT CONTENT*

I. Web of Life

- A. Interdependence of Plants and Animals (Producer, Consumer, and Decomposer)
- B. Food Chains and Pyramids
- C. Mineral Cycles (and Others)
- D. Man in Nature
  1. Forest Fires and Control
  2. Water Conservation and Flood Control
  3. Animal Conservation
  4. Others (Radiation, Poisons, Drugs, Alcohol, Tobacco)

II. Populations and Communities

- A. Rise and Fall of Populations
- B. Plant and Animal Successions

III. Ecological Biogeography

- A. Physical Environment (Climatic Conditions)
- B. Biotic Environment
  1. Predation
  2. Saprophyte, Scavenger, Decomposer
  3. Symbiosis (Parasitism, Commensalism, Mutualism)

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C. Principles of Distribution (Biotic Communities-Biome)

1. Fresh-water
2. Marine
3. Forest
4. Desert
5. Mountains
6. Grasslands

UNIT FOUR: CHANGE AND CONTINUITY OF LIFE

The outline of content and concepts for Unit Four are designed to help students develop an understanding of how living organisms are equipped in a variety of ways for coping with their environment. The basic tenet that living things reproduce offspring of their own kind is emphasized in this unit.

Class members will learn that all life on earth, whether it is living or extinct, has descended from pre-existing life. Basic understandings of the mechanisms of heredity, gene pools operating in populations, and the effect of mutations are stressed in this unit. Emphasis is also placed on concepts concerning chromosomes, their molecular structure, and the chemical nature of heredity; and important historical ideas on how living things change. Students will have a more complete picture of the living world around them at the conclusion of this unit.

Estimated teaching time: 4-5 weeks

UNIT FOUR: CHANGE AND CONTINUITY OF LIFE

CONCEPTS TO BE DEVELOPED

Mitosis is the regular division of a cell in which each of the two daughter cells receive exactly the same number and same kind of chromosomes that the parent cell had.

Constancy of chromosome number in cells of successive generations of living organisms is insured by meiosis.

Asexual reproduction is characterized by the presence of a single parent that splits, fragments, or produces spores so as to give rise to two or more offsprings.

Sexual reproduction is a fusion of two nuclei from different cells into one cell (zygote).

Each cell of every organism of a given species contains a characteristic number of chromosomes.

Living organisms on earth today represent the current time segment in a continuing process of change.

Any population with a common ancestry is likely to have about the same percentage of each generation showing each hereditary trait... population equilibrium.

Evolution occurs more rapidly at some times than at others.

Evolution does not proceed at the same rate among different types of organisms.

Evolution is characteristic of populations, not of individuals, secured through the processes of mutation, recombination, natural selection and genetic drift.

UNIT FOUR: CHANGE AND CONTINUITY OF LIFE

OUTLINE OF UNIT CONTENT*

I. Continuity of Life

- A. Cell Reproduction
  - 1. Mitosis
  - 2. Meiosis
- B. Asexual Reproduction
- C. Sexual Reproduction
- D. Embryology

II. Patterns in Heredity

- A. Chromosome and Heredity
- B. Mechanism of Heredity

III. Changes in Living Things

- A. Mechanism of Evolution
  - 1. Early Ideas (Aristotle, Lamarck, and Others)
  - 2. Natural Selection
  - 3. Adaptive Radiation
    - a. Food Getting
    - b. Mimicry, Coloration, and Camouflage
    - c. Migration, Hibernation, and Aestivation
    - d. Mating and Nesting
- B. Evidence of Evolution
  - 1. Geologic Timetable and Fossils
  - 2. Others
- C. Changes in Primates

*Learning experiences and student activities correlated with this outline course of study have been developed in resource units and may be secured from the Curriculum Branch, Division of Instructional Services.